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Controlling Air Pollution In Metropolitan Toronto



Ontario

Ministry of the Environment

Hon. J.A.C. Auld
Minister

Everett Biggs
Deputy Minister

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Introduction

The control and prevention of air pollution in Ontario became the full responsibility of the Ontario Government on January 2, 1968 when the Air Pollution Control Act, 1967 went into effect. Prior to that date, air pollution control had been under municipal jurisdiction. The province had functioned in an advisory capacity.

The Air Pollution Control Act has since been superceded by the Environmental Protection Act, 1971, and is administered by the Air Management Branch of the Ministry of the Environment. The Branch has the authority to conduct air quality and meteorological studies and monitoring programs, establish acceptable air quality levels, and to inspect and regulate all sources of air pollution.

One of the Branch's major areas of concern has been Metropolitan Toronto. This report summarizes the progress the Branch has made in its air management program for Toronto from January 2, 1968, when it assumed control, to December 31, 1972.

Summary of Air Pollution Control Progress in Metropolitan Toronto

The City of Toronto's first air pollution control measure was an anti-smoke by-law passed in 1907. Additional measures were subsequently adopted, but it was not until 1949 that an effective by-law for the control of black smoke was adopted, first by the City of Toronto and later, in 1957, by Metropolitan Toronto, to include all of the then existing 13 Metro municipalities.

By 1968, when the province assumed control, 95% of Toronto's once serious black smoke problem had been eliminated. However, much remained to be done about other smoke and dust problems, as well as about gaseous emissions from a wide variety of burning and other chemical processes.

Since January, 1968, considerable progress has been made:

1. Abatement programs have been or are being established for all large stationary sources of air pollution. (By December, 1972, 237 industrial abatements and 1,378 fuel conversions had been carried out.)
2. An air pollution index and alert system has been put into operation that allows the Minister of the Environment to curtail the operations of major sources of air pollution as certain index levels are reached.
3. A detailed survey of all sources of air pollution has been completed in connection with a specially developed mathematical model. When fully developed, the model will allow the Air Management Branch to evaluate strategies for the control of existing pollution problems and anticipate future ones.
4. A regulation restricting the sulphur content of fuels sold or used in the Metro area has been in effect since June 1, 1971 and has resulted in significant reductions of sulphur dioxide emissions.

The overall effect of these measures, in addition to other general provisions introduced under the Environmental Protection Act, 1971, has been to put Metropolitan Toronto well on the way to achieving a satisfactory degree of air quality. As in the rest of Ontario, all new potential sources of air pollution must incorporate appropriate control

systems. Within the next few years, virtually all existing sources will also be under control, emitting either no pollutants at all or pollutants at acceptable levels of concentration. When this degree of control will have been achieved, pollution build-ups will occur only under extremely stagnant weather conditions.

Sources of Air Pollution in Metropolitan Toronto

Stationary Sources: Five basic categories have been established for stationary sources of air pollution - industrial facilities, commercial and public buildings, schools, apartment buildings, houses. The following list indicates their numbers:

1.	Large point sources (A special grouping of large sources from all categories. Included are both the Hearn and Lakeview generating stations, large industries and hospitals, the Metropolitan Toronto incinerators, large educational and other institutional facilities.)	106
2.	Intermediate industries	1,066
3.	Commercial and Public Buildings	37,130
4.	Apartment Buildings	5,500
5.	Houses	480,000

The elimination or reduction of air pollution from these sources is being accomplished in two basic ways.

1. Certain known sources, and others brought to the Branch's attention by means of complaints, are approached directly and individual solutions are developed. Most involve the establishment of abatement programs by which emissions of pollutants are reduced to conform with emission standards under the Environmental Protection

Act. In some instances, owners of air pollution sources may instead decide to shut down their operations or relocate them.

Emission standards specifically indicate the amounts of pollutants (gases and dust particles) permitted to enter the atmosphere over fixed periods of time. Health and vegetation effects and aesthetic considerations play an important role in their determination.

Legal action can be initiated if they or other aspects of a regulation are violated.

2. Special regulations, most of which apply to all of Ontario, are being made under the Environmental Protection Act. Two regulations outline controls for specific types of industrial operations - ferrous foundries and asphalt paving plants. A third, is the regulation restricting the sulphur content of fuels used or sold in Metropolitan Toronto.

Mobile Sources: Four basic categories have been established for mobile sources of air pollution - motor vehicles (passenger cars, buses, trucks) ships, trains, aircraft.

Mobile sources present a difficult control problem as only motor vehicles fall under the jurisdiction of the Environmental Protection Act.

Motor Vehicles: At present, exhaust emissions from all passenger cars and some types of trucks and buses are governed by regulations under the Act.

The first of these regulations went into force at the beginning of the 1969 model year. As a result, 1970 passenger cars produce only 30% of the emissions that come from 1968 models. More efficient

controls are in effect for 1971 and 1972 models.

Ships, Trains, Aircraft: All aspects of ship, train and aircraft operation fall under the jurisdiction of the Federal Government. Air pollution from these sources, therefore, cannot be regulated under Ontario's Environmental Protection Act. The Air Management Branch can and does, however, enforce the existing federal provisions concerning air pollution from these sources.

Smoke emissions from ships in Canadian waters are regulated under the Canada Shipping Act. Smoke emissions from locomotives and other railway property are regulated by Canada General Order 0-26, issued by the Board of Transport Commissioners for Canada. No regulations have been developed to control aircraft exhausts, although both Air Canada and CP Air have undertaken to substantially reduce black smoke emissions from a large number of their planes.

Measuring Air Pollution in Metropolitan Toronto

The Air Management Branch has established a province-wide air pollution monitoring system to locate and measure the concentrations of various pollutants. As of January 1, 1973, about 900 instruments were located in about 50 communities. Of this number, 190 were spread across Metropolitan Toronto in 45 locations.

Primary pollutants measured are:

1. Sulphur dioxide, emitted primarily from industrial and power generating operations burning coal and oil with high sulphur content.
2. Suspended particulate matter from a wide variety of operations

producing large amounts of dust and smoke.

3. Carbon monoxide, primarily from motor vehicles.
4. Hydrocarbons, primarily from motor vehicles.
5. Oxides of nitrogen, primarily from power generating operations and motor vehicles.

Available data up to the end of 1972 indicates that air quality in Metropolitan Toronto has improved substantially in the past few years, and very greatly since the mid-sixties. See Figures 1 and 2.

1. Sulphur dioxide: The concentration of sulphur dioxide in downtown Toronto decreased from an annual average of 0.10 parts per million in 1967 to 0.03 ppm in 1972, a drop of 70%. Annual averages for suburban areas in 1972 were approximately one-half of the downtown average.

The level of sulphur dioxide established as a desirable goal under the Environmental Protection Act is an annual average of 0.02 ppm. Existing levels have been reduced steadily to meet this figure as more air pollution abatement programs came into effect. Of 12 Metropolitan Toronto stations, all but two downtown stations met this goal in 1972.

The Hearn Generating Station's partial fuel conversion from coal to natural gas decreased sulphur dioxide emissions in Metropolitan Toronto 110 million pounds per year.

2. Suspended particulate matter: Concentrations of suspended particulate matter have also been decreasing. This is directly indicated by the results of two standard forms of measurement:
 1. The Soiling Index, a measure of fine dust particles in the air

based upon an optical method of calculation.

2. Weight by volume; expressed in micrograms per cubic metre, which includes particulate matter of all sizes.

The Soiling Index decreased in the City Hall Area from an average of 0.7 in 1967 to 0.32 in 1972, a drop of approximately 54% in fine dust concentration. At the University of Toronto monitoring site, the Index decreased from 0.8 in 1967 to 0.34 in 1972, a drop of 57% for that location.

The Soiling Index reading established as a desirable goal under the Environmental Protection Act is 0.45, a figure that has now been reached in most of Metropolitan Toronto (12 of 13 sampling stations).

Figures available from another downtown monitoring station (67 College Street) show drops in averages from 194 micrograms per cubic metre in 1962 to 86 micrograms per cubic metre in 1972. The desirable goal is 60 micrograms per cubic metre. Continued pollution abatement will bring total particulate levels closer to this figure.

Abating Air Pollution in Metropolitan Toronto

The actual locating and abatement of air pollution sources is the work of the Abatement Section of the Air Management Branch. This activity is conducted from 15 offices located across the province in seven regions. Six of the regions encompass varying numbers of southern counties or northern districts. The remaining region is Metropolitan Toronto, set aside on its own because of population (approximately 2,000,000) and a high concentration of air pollution sources. Abatement staff in the Toronto region includes 23 engineers and inspectors.

In Toronto, as elsewhere in Ontario, pollution sources are being dealt with on a priority basis aimed first of all at the control of large industrial and institutional point sources. In each case, an emission survey is made of the operations. The owner is then given a written report outlining the control measures required, a stated time in which to submit an application for a Certificate of Approval and a compliance time for correction.

The aim of abatement programs is to stop emissions of air contaminants if possible, or reduce them to acceptable levels of concentration. Acceptable levels of concentration in each instance and therefore the degree of actual control depend upon the location of the source, the type of pollutant emitted, and the expected adverse effect upon receptors downwind from the source.

Not all air contaminants, of course, can be eliminated. At low levels of concentration under most weather conditions, however, they are dispersed into the atmosphere. Pollution build-ups will continue to occur even after all air pollution sources have been brought under control (i.e. emitting pollutants in allowable quantities), but only during prolonged periods of stagnant weather.

Industrial Abatement:

1. the relocation or elimination of a source of pollution, or
2. the reduction of the effects of emissions from a source by means of process alteration or installation of additional equipment.

Fuel Conversion: Change-over from the burning of coal or high

sulphur content oil to natural gas or low sulphur content oil. Approximately 90% of these conversions have been to natural gas.

The 237 industrial abatements and 1,378 fuel conversions are the result of specifically negotiated programs worked out between the Air Management Branch and the owners of air pollution sources. Forty-eight programs have been carried out under Control Orders or Program Approvals.

Inspection: Visual examination of actual operation and equipment (e.g. apartment building incinerators).

Survey: Complete examination (including process calculations) of an air pollution source.

Observation: Outdoor sighting of smoke emissions or the encountering of odours, either during routine district tours or as the result of a complaint or other specific suggestion to observe a particular situation.

Observations were naturally high in number in 1968 and 1969 because of general visual surveys initially conducted to record the overall extent of Toronto's air pollution problem. Their decrease in number through 1972 also reflects the increasing number of fuel conversions and abatement programs being completed.

Complaint: Phone call or letter received about discomfort or damage due to air pollution (smoke, soot, odours) which is subsequently investigated by an inspector.

A complaint service was established across the province to help define the pollution problems of known sources and to reveal unknown sources. The number of complaints received from 1968 to 1971 increased as the

public became more aware of the service. The decrease in numbers recorded in 1972 is an indication that major sources of air pollution are now under control.

Air Pollution Index and Alert System

A significant aspect of Ontario's air management program is its air pollution index and alert system. The index was established to give warning of and to prevent the adverse effects of air pollution build-ups during prolonged periods of stagnant weather. At the end of 1970, it was in operation in Toronto and Hamilton. Since then, it has been extended to include Sudbury and Windsor.

The index is based upon continuous measurements of sulphur dioxide and suspended particulate matter, Ontario's two major air pollutants. Both have been found in high concentrations during severe air pollution episodes in other parts of the world, and extensive data is available relating severity of health effects to degree of pollution.

The structure of the index is a numerical scale beginning at 0. Readings below 32 are considered acceptable, indicating concentrations of sulphur dioxide and suspended particulate matter that should have little or no effect on human health. At 58, people with chronic respiratory disease may be affected. At 100, prolonged conditions could have mild effects on healthy people and serious effects on those with severe cardiac or respiratory disease.

The alert system functions at four index levels: 32 (Advisory Level), 50 (First Alert), 75 (Second Alert), 100 (Air Pollution Episode Threshold Level).

At 32, if meteorological conditions are expected to remain unfavourable for at least six more hours, owners of major sources of air pollution may be advised to prepare for possible curtailment of their operations. At 50, under continuing adverse meteorological conditions, they can be ordered to curtail them.

At 100, the Minister of the Environment can order all sources of air pollution not essential to public health or safety to cease operations. A reading of 100, however, is unlikely to ever be reached because of previous provisions for curtailment at lower index levels.

The highest Toronto index reading in the past, calculated in retrospect from measurements taken at the time, would have occurred between November 30 and December 4, 1962. The index would have reached a peak of 155 during the evening of December 1, and 125 during the early morning hours of December 4. The average reading over this four-day period would have been 95.

The most significant aspect of this particular pollution build-up was a dense smog which caused that year's grey Cup game to be played on two separate days. There was no recorded increase, however, in hospital admissions of people with respiratory ailments during this period, an indication of the margin of safety built into the index.

The Air Pollution Index and Related Abatement Activity in 1970

The index went into operation in Toronto on March 23, 1970. Between then and December 31, the Advisory Level of 32 was exceeded on 17 occasions and the First Alert Level of 50 was exceeded twice. Highest index reading to date was 56 on October 8, 1970. During 1971, the

index exceeded 32 on 19 occasions and once over 50. During 1972, the index exceeded 32 twice, never exceeding 50.

Abatement activity on these occasions began as the index reached 32, with telephone calls to the larger sources of air pollution on the API Calling List. (The list is a record of all air pollution sources emitting at least 4,000 pounds of either sulphur dioxide or suspended particulate matter a week. As many as 50 sources were listed at any given time.)

In each case, the owner or operator of the source was advised of the index level and requested to prepare for possible curtailment of his operation. Many, however, responded immediately and actually reduced operations while the index was still at 32. Such co-operation, especially when the index was rising rapidly and unfavourable weather conditions were expected to continue for some time, helped prevent the index from rising to 50 except on the three occasions mentioned.

When the index rose over 50, the Minister of the Environment issued Ministerial Orders instructing 20 air pollution sources to reduce their respective emissions of either sulphur dioxide or suspended particulate matter.

Operations emitting large amounts of sulphur dioxide (e.g. Hearn Generating Station) are able to reduce emissions by either cutting back production or switching to a lower sulphur content fuel.

Operations producing large amounts of suspended particulate matter (e.g. the Metropolitan Toronto incinerators) can only reduce emissions by cutting back production.

Function of the A.P.I. Calling List

As already indicated, the A.P.I. Calling List functions as a ready guide for the Air Management Branch when immediate abatement action is required due to high index readings. By having the larger sources of pollution reduce emissions, a pollution build-up can usually be checked.

Actual composition of the list varies from time to time. Operations not previously on the list are added when their emissions exceed either 4,000 pounds of sulphur dioxide or suspended particulate matter a week. Operations on the list are removed when their emissions fall below this level because of abatement programs or for other reasons.

Some sources of air pollution on the list are operating in accordance with design standards established under the Environmental Protection Act. They are, in other words, emitting contaminants at allowable rates but, because of size, their total emissions exceed 4,000 pounds a week.

The allowable rate of emission for a given contaminant from a particular source is determined by (1) calculating what the subsequent concentration of an emitted contaminant will be point of contact with an object that could be adversely affected by it (man, animals, vegetation, buildings), and (2) comparing that concentration with the design standard or maximum concentration allowed for the contaminant. If the calculated concentration is too high, modifications become necessary to reduce the amount of contaminant being emitted at the source.

The point of contact mentioned above is referred to as the "point of impingement". It is the point of contact between a plume or effluent

stream and an object that might be adversely affected. It can occur at ground level or above (e.g. the side of a building).

Concentration figures at point of impingement are averages calculated for periods of 30 minutes. The maximum concentration allowed for a given contaminant is well below that at which adverse effects would actually occur.

The maximum allowable concentration of sulphur dioxide at point of impingement is 0.3 parts per one million parts of air by volume averaged over a period of 30 minutes. The maximum allowable concentration of suspended particulate matter at point of impingement is 100 micrograms per cubic metre of air averaged over a period of 30 minutes.

An important factor influencing the composition of the list is the use of natural gas as a fuel. When burned, natural gas produces only minute traces of sulphur dioxide, and numerous operations are being converted to it to reduce emissions of this pollutant. At the present time, however, there is a general shortage of this fuel and it is only available on a year-round basis to essential services. Other operations are restricted to its use on an "interruptible basis". They are supplied with natural gas for most of the year except during a mutually agreed upon interruptible period when they must burn another fuel, normally oil. The interruptible period varies in length from five to 90 days and usually occurs in the winter months when fuel demands are highest.

This procedure has an obvious influence on the A.P.I. Calling List. An operation burning natural gas on an interruptible basis will not,

of course, be on the list while actually using the fuel, but it may be during its interruptible period. Whether or not it will be depends upon both the amount and sulphur content of the coal or oil being used in place of natural gas.

Abatement Progress of 8 Metropolitan Toronto Firms and Institutions

As a result of the ready availability of natural gas, a number of large industries and very small ones in Toronto have been able to convert to gas with a corresponding (and very significant) reduction in emissions of sulphur dioxide and particulate.

Table I summarizes the reduction in emissions from eight major industries in Toronto.

Ontario Air Quality Simulation Models

The complexity of air pollution problems in large urban areas and the immense number of calculations required to encompass the large number of sources of air pollution and climatic conditions has necessitated the development of computerized mathematical models. The initial model, for Metropolitan Toronto, was designed by the Air Management Branch, in conjunction with H. H. Angus and Associates and the Research Corporation of New England.

Model development started in July, 1969, and was completed by April, 1971. The scope of the model has since been increased by the Air Management Branch staff and extended to other areas of Ontario, including Hamilton and Sudbury. The completion of the Niagara Peninsula model before the end of 1973 will provide a tool for regional planning for the area from Toronto to Hamilton to Niagara Falls. Other

locations are in the inventory stage, and complete data for modeling purposes in all of Ontario is anticipated by 1975.

Application of the model enables the Air Management Branch to evaluate different abatement strategies for existing pollution sources and predict changes in air quality resulting from the construction of new sources, land-use plans, population changes, and the implementation of new regulations (e.g. those governing automotive exhaust emissions and fuel sulphur content).

Pollutant emissions are obtained from the Ontario Pollutant Inventory System, which originally served only as an information system for the Toronto Simulation Model, but now has wide application to a series of management and scientific systems. This pollutant inventory is continually updated and serves as a valuable electronic filing system of air management facts, allowing quick summary of any required data. In particular, it enables the Branch to provide rapid and complete information to municipal developmental agencies (planning board, etc.) that wish to incorporate air management factors within urban and regional planning studies.

Fuel Sulphur content regulation

A special regulation limiting the sulphur content of fossil fuels used, sold or offered for sale in Metropolitan Toronto has been introduced because of the area's high concentration of fuel burning operations. It reduces the maximum sulphur content of fuel oil (grades 1, 2, 4, 5, 6C) and bituminous coal within a phased program on the following dates - January 1, 1971; January 1, 1972; January 1, 1973.

Sulphur content limits effective January 1, 1971, range from 0.5 per cent for No. 1 fuel oil to 2.0 per cent for bituminous coal. The final limits, effective January 1, 1973, are 0.5 per cent for fuel oils 1 and 2, and 1.5 per cent for fuel oils 4, 5, 6B, 6C, and bituminous coal.

Implementation of the regulation has substantially reduced emissions of sulphur dioxide in Metropolitan Toronto. Further sulphur content reductions would have to be considered if the supply of natural gas was restricted and large sources had to turn to other fuels as their main source of supply.

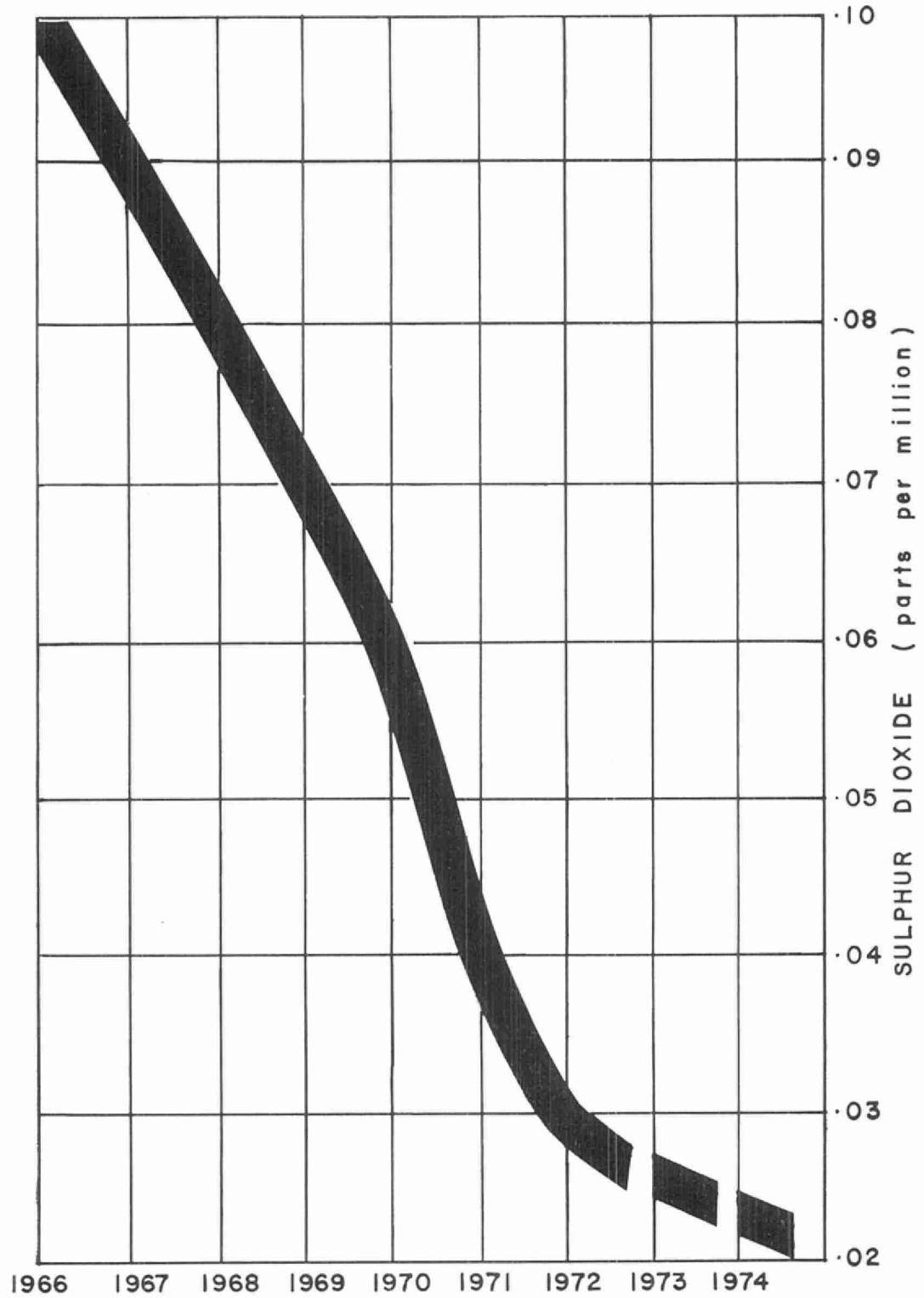
Summary

The basic methods of controlling air pollution have been established and implemented with considerable success in Metropolitan Toronto over the last five years, as reflected by decreasing levels of pollutant concentrations. Abatement programs, fuel conversions, special regulations and the air pollution index and alert system have all played a role, and will continue to do so as air quality is steadily improved.

The work ahead consists of continued control and prevention, greater refinement of techniques, and the more direct application of the knowledge gained from air pollution control work to the actual planning and development of urban areas. In this regard, the mathematical model will play an important role and will increasingly be a factor in the day-to-day work of air management.

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SULPHUR DIOXIDE CONCENTRATIONS
METROPOLITAN TORONTO



SUSPENDED PARTICULATE MATTER CONCENTRATIONS : METROPOLITAN TORONTO

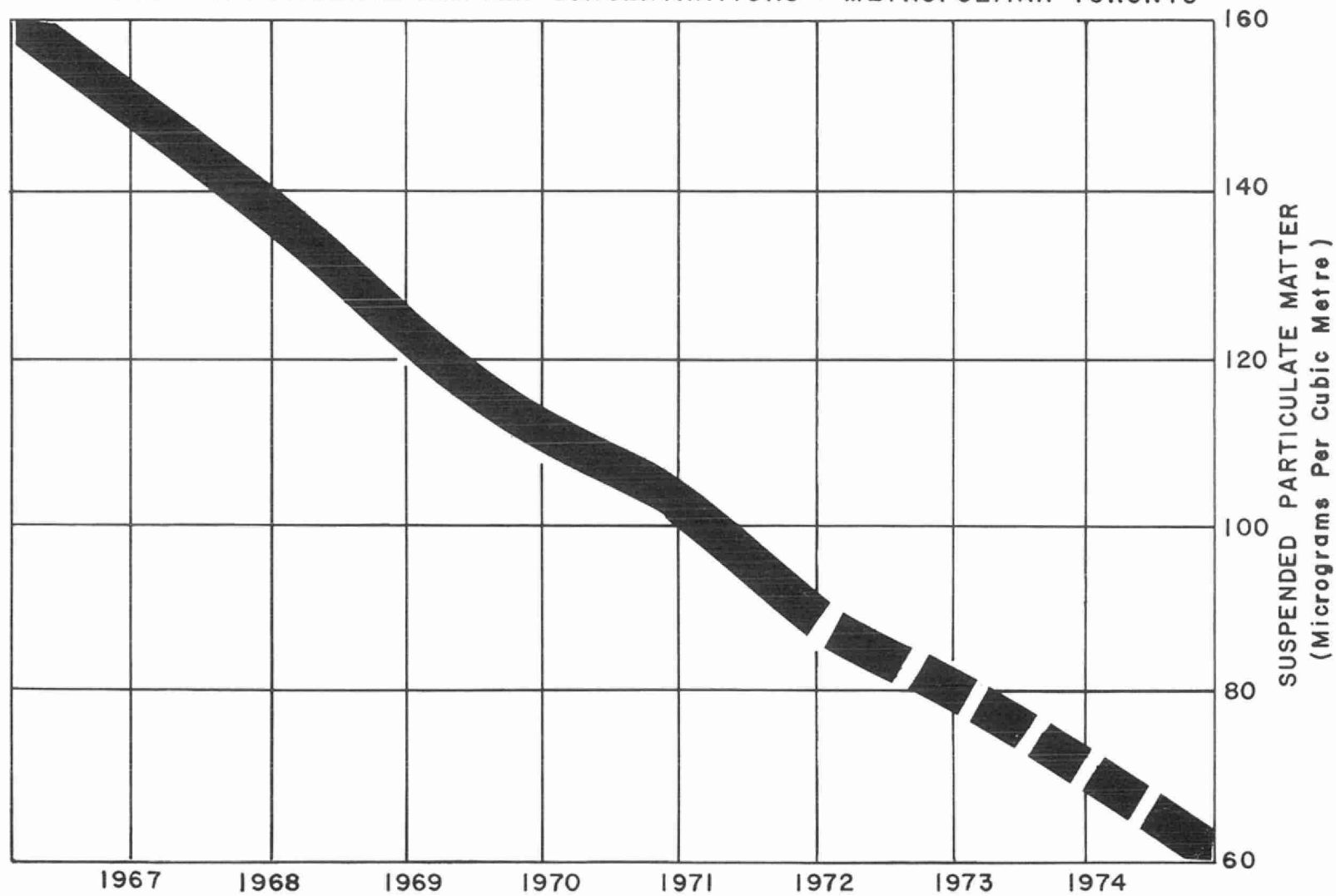


TABLE I:

The following table summarizes abatement activity in Metropolitan Toronto from
January 2, 1968 to December 31, 1972.

	<u>1968</u>	<u>1969</u>	<u>1970</u>	<u>1971</u>	<u>1972</u>	<u>Total</u>
Industrial Abatements	19	45	64	56	53	237
Fuel Conversions	220	240	583	219	116	1,378
Inspections & Surveys	1,300	2,800	10,106	9,167	4,796	28,169
Observations	36,200	21,000	7,926	11,105	5,723	81,954
Complaints Received	2,500	3,100	5,023	5,512	4,155	20,290

TABLE II:

COMPANY	ABATEMENT (CONVERSIONS)	POLLUTANT REDUCTION lbs/yr.	
		SO ₂	PARTICULATE
R.L. HEARN GENERATING STATION	4 Units from coal to gas 4 Units from coal to dual firing coal/gas	109,000,000	14,880,000
GOODYEAR TIRE & RUBBER CO. LTD.	From bunker C oil to gas and #2 oil	3,700,000	121,000
TORONTO TERMINALS RAILWAYS	From bunker C oil to gas and #2 oil	3,214,000	
TORONTO GENERAL HOSPITAL	From bunker C to gas and #2 oil	1,700,000	212,000
CAMPBELL SOUP CO. LTD.	From bunker C to gas and #6 oil	1,800,000	70,000
UNIVERSITY OF TORONTO	From bunker C to gas and #2 oil	700,000	
ANACONDA BRASS (CANADA) LTD.	From bunker C to gas and #2 oil	920,000	
CANADA CYCLE AND MOTOR CO. LTD.	From coal to gas and #2 oil	140,000	320,000
TOTAL		121,174,000	15,603,000

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